Meson Test Beam Use

Erik Ramberg

AEM, 28 Nov. '05

- Summary of MTBF user facility
- Beam types and rates
- Overview of approved and planned experiments

Web page for MTBF: http://www-ppd.fnal.gov/MTBF-w or Fermilab-at-Work
Test beam coordinator: Erik Ramberg - ramberg@fnal.gov - 630-840-5731

Meson Test Beam Facility

Introduction

The Meson Test Beam Facility is a versatile beamline in which users can test equipment or detectors in a beam of moderate energy particles (5-120 GeV) at moderate intensities (<1 MHz). Beamtime is available to qualified users as discussed below.

Weekly schedule for primary user

Assignment of user areas

MT6 Phone Numbers

Beamline and experimental area details

How to become a test beam user

Resources available for approved test beam users

"How to..." Pages

Meson Test Beam Facility MOU's

Meetings and Talks

Email archive for test_beam@fnal.gov

Useful links to Beams Division status and logs

Pictures

Details of beamline and user areas:

A layout of the Meson Lab, MTest beamline elements and MTest user areas can be found here:

- MTest User Areas Rough Outline (ps,ppt)
- Meson Lab Drawings (pdf) (ps)
- Meson Lab Autocad file (AutoCad) (IDEAS)
- MTest User Areas with radiation survey data (ps)
- MTest Beamline Elements (pdf)
- All SY120 Beamline Elements (pdf)
- Electrical system at Mtest (pdf)

A description of the time structure of the beam: (txt)

Results on composition of beam using Cerenkov detectors:
- Threshold plots: 120 GeV , 66 GeV , 33 GeV , 16 GeV , 8 GeV
- Threshold pressures vs momentum (Excel)
- Documentation of threshold curves

Study of multiple tracks as a function of rate and gate width: (postscript)

Tune parameters:

- 120 Gev, narrow beam (pdf)
- 120 Gev, recent tune (pdf)
- 66 Gev (pdf)

A spreadsheet has been made by the beamline physicist, Tom Kobilarcik. Here is the latest version of this spreadsheet and the resulting predicted rates as a function of momentum. (pdf,word)

MTest beam sheet and data file

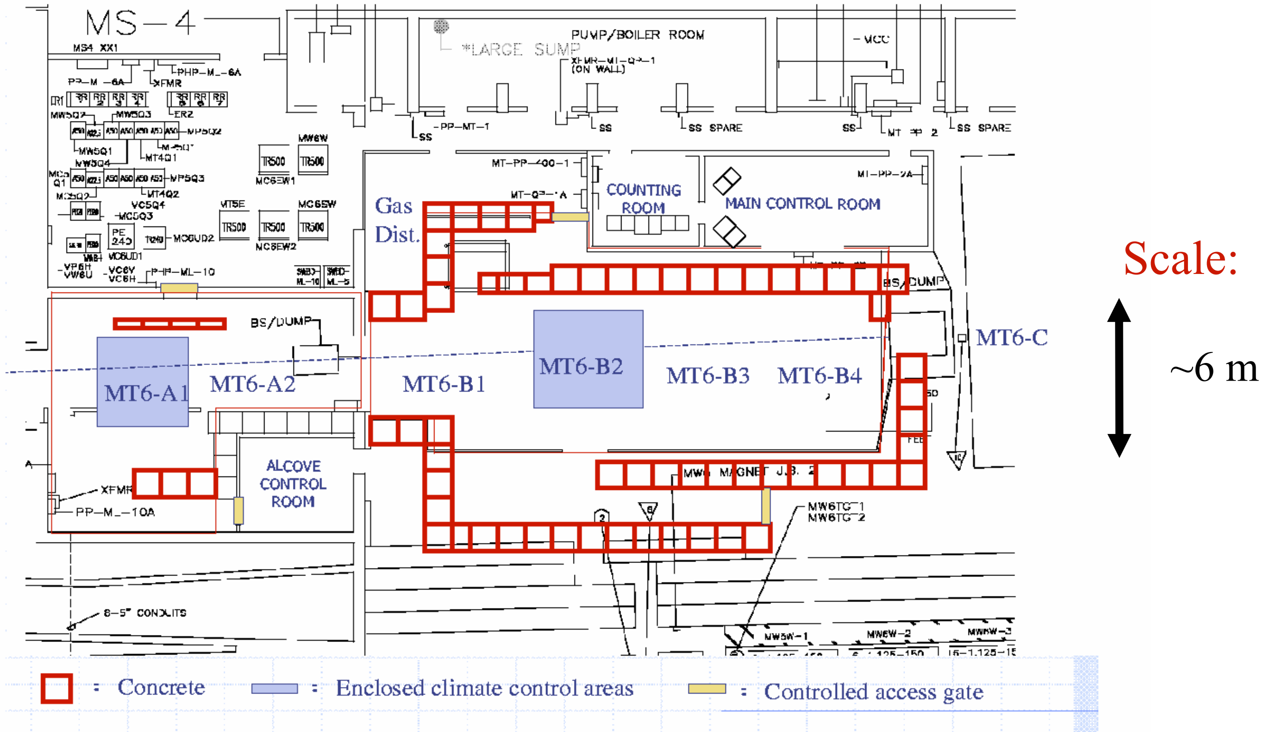
Safety documents related to the MTest facility are here:

- PPD Safety Assessment Document/Readiness Review (doc)
- MTest User Areas Radiation Assessment Calculation (ps)
- Radiation Shielding Assessment for the MT6 area (doc)

The MTest beamline was operated in 1999 for test purposes with an 800 GeV primary energy and a description of the operation of that run is in this memo:

- A New MTest Beamline for the 1999 Fixed Target Run
  T. Kobilarcik, C. Brown (ps, pdf)

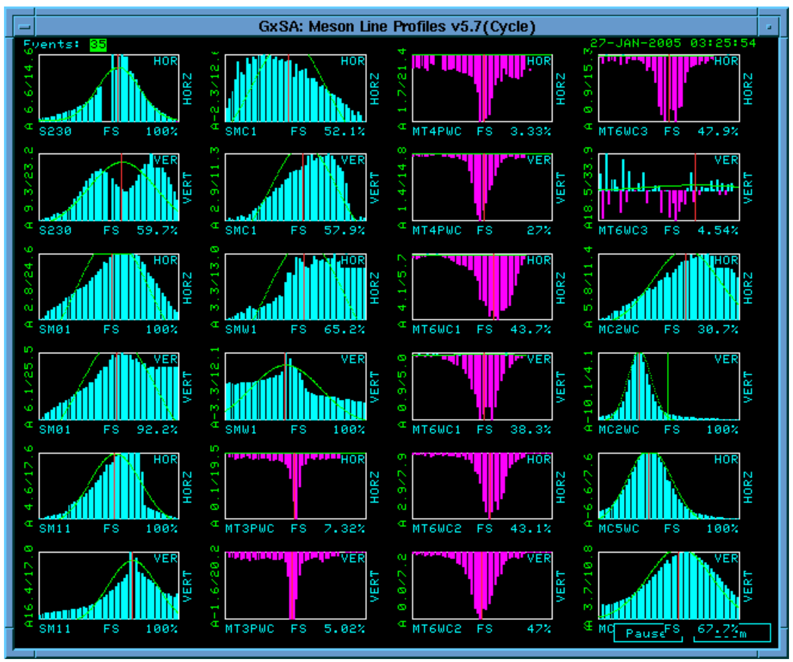
MT6 Test Beam User Areas



- 2 beam enclosures, but cannot be operated independently.
- 6 user stations, with a 7th downstream of the beam dump. An experiment can take up more than one station.
- 2 climate stabilized huts with air conditioning.
- 2 separate control rooms.
- Outside gas shed + inside gas delivery system brings 2 generic gas lines, 1 nitrogen line and 2 exhaust lines to each of the user areas
- Lockable work area with 3 offices for small scale staging or repairs, plus 2 open work areas.

Operational Characteristics of Test Beam Line

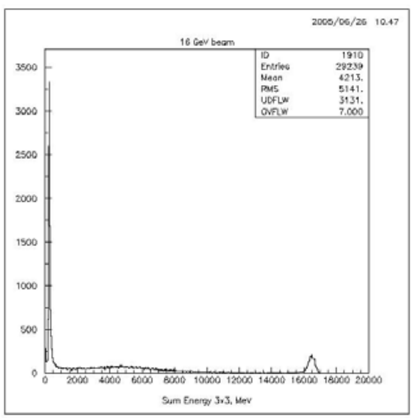
- 120 GeV protons impact on 40 cm long block of Aluminum as a production target.
- There are two operational modes of the test beamline:
  - Proton Mode: Tune beamline for 120 GeV protons that get transmitted through the target
  - Secondary Mode: Vary the tune of the beamline according to the momentum desired. Maximum momentum is 66 GeV while minimum momentum achieved so far is 3.7GeV. Lower momenta are conceivable, but pion rate will be quite low and electron scattering will probably be quite high.
- Spot sizes can be made as small as 3-5 mm square (with 120 GeV protons) and as large as 5 cm square.



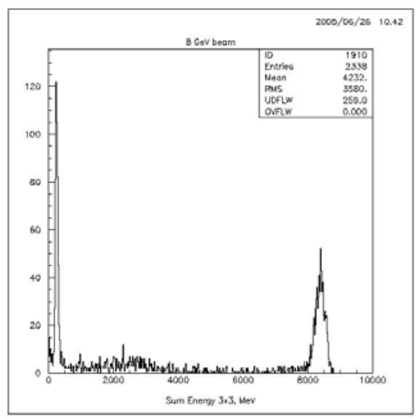
Typical SWIC profiles while delivering 120 GeV beam (1 mm wire spacing: ~ 7 mm RMS)

Electrons at MTBF

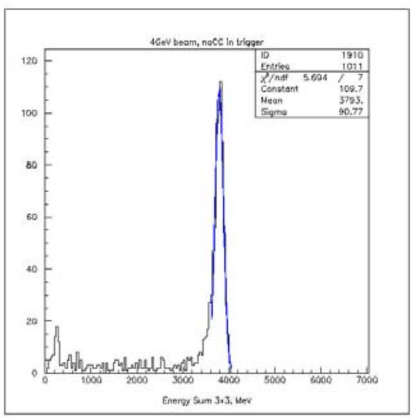
- During the last run of the BTeV EMCAL group in June, the lead tungstate calorimeter was calibrated using MIP peaks.
- Momentum selected electrons were easily identified in the 4, 8, 16 and 33 GeV tunes.
- Improvements in the beamline (better vacuum and reduction of material) made for a better electron peak.
- The two Cerenkov detectors worked quite well and can participate in the trigger.



16 GeV tune



8 GeV tune



4 GeV tune

PARTICLE RATE IN MTEST

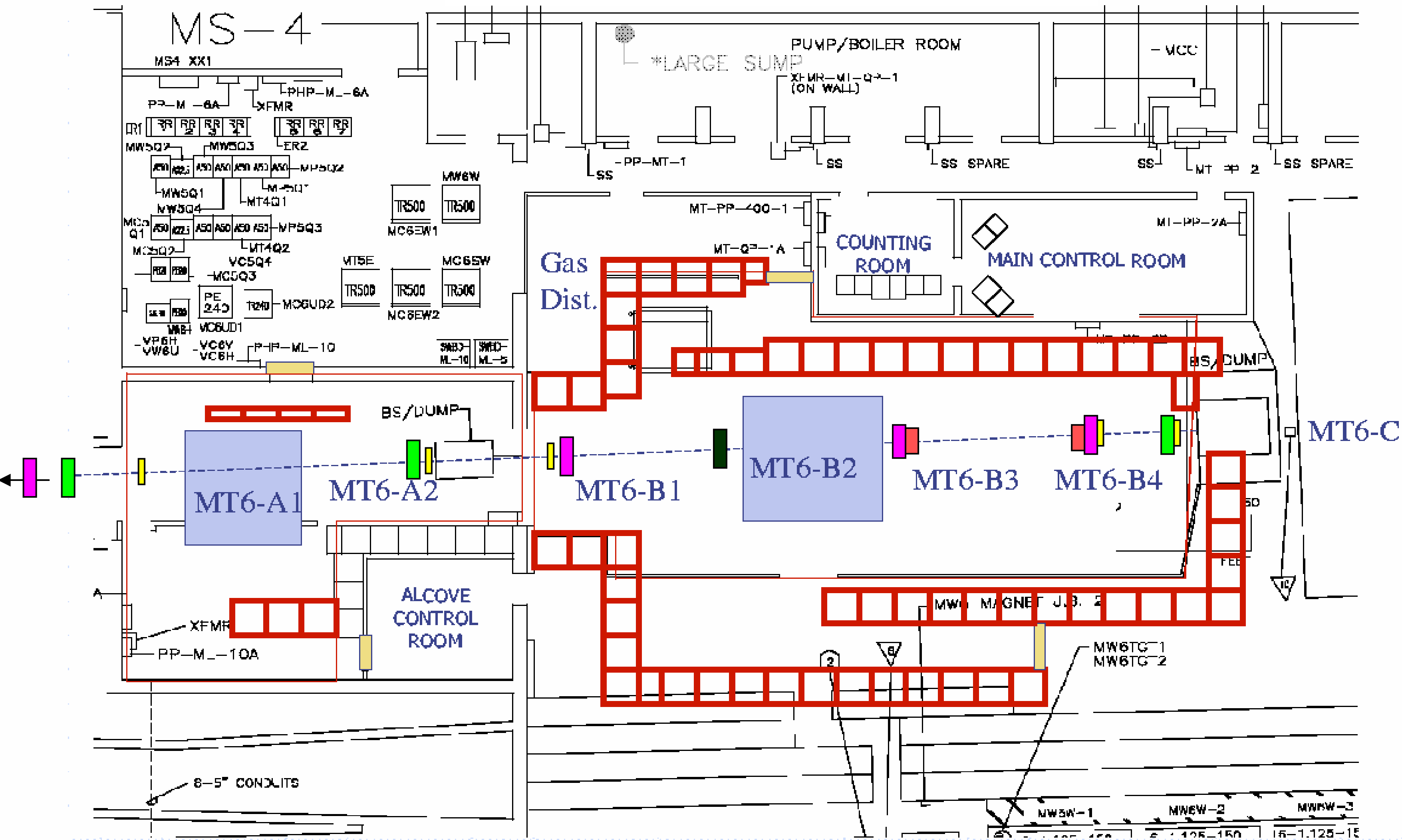
Particle Energy (GeV)	Protons/spill (From the MI to SY120) - ***	Rate measured at MT6SC2	Date rate measured	Beam Condition (Batches, Bunches, Turns)	Source of Information	MT6SC2 rate normalized to 1E12 Protons/spill	Electron Fraction$$
120	0.5-0.6E12 2E12 1.0-1.2E12	150-180K 850-900K 400-500K	1st Aug. 05 29th Jun. 05 29th Jun. 05	1, 60, 2 5, 84, 1, 3, 84, 1	EBL Log BCC Log EBL Log	400-450K	0
66	1.0-1.1E12	35-40K	28th Jun. 05	3, 84, 1	EBL Log	35-40K	~0
33	0.35E12 0.35E12	11K 12K	18th Aug. 04 22nd Nov. 05	1, 60, 2 NA	EBL Log EBL Log	30K	~0.7%
16	0.50-0.55E12	8.5K-9.5K	10th Nov.05	1, 60, 2	EBL Log	17K	~10%
8	1.1E12 0.85E12	5.5K 2.0K	18th Nov.05 1st Jul. 05	1, 84, 3 3, 84, 1	EBL Log EBL Log	2.5-5.0K %%	~30%
4	1.0E12 0.8-0.9E12 1.5E12	~330 150-200 1050	19th Nov. 05 1st Jul. 05 24th Nov. 05	1, 84, 3 3, 84, 1 2. 84, 2	EBL Log EBL Log EBL Log	220-330 %% 700##	~60%
3	1.5E12	250	24th Nov. 05	2, 84, 2	EBL Log	160	

1. The spill length is 6 sec. Flat top for beam extraction is 4 sec. At present one spill every 2 minutes is allocated to SY120.
2. *** - Beam shared by MCenter and MTEST. Thus the actual proton used for secondary particle production in MTEST is less than what is defined in column 2. If only MTEST gets all the beam the rate in column 7 can be increased by ~25-33%.
3. $$ - Information from Erik Ramberg and test beam users.
4. %% - Although for 8 and 4 GeV, a large variation in measured rate is shown, I will be more inclined to take the larger of the numbers as baseline measured rate.
5. ## Effect of proper tuning. Chuck's Magic hand.
6. At lower energy, especially at 8 GeV and below, proper tuning is very crucial for higher rate as evidenced from large rate variation.
7. Shielding limit in MTEST is
   a. 2E12 protons/2.9Sec from M02 to M03 pinhole collimator, and
   b. 2E7 particles/2.9Sec from M03 pinhole collimator and downstream.

Facility Detectors

- Two beamline threshold Cerenkov counters can be operated independently for good particle i.d. (50’ and 80’ long)
- Two stations of X,Y silicon strip detectors are installed.
- One 0.5 mm pitch MWPC and two 1.0 mm pitch MWPC into DAQ
- Three 1.0 mm pitch MWPC into the accelerator ACNET control system.
- DAQ accepts custom triggers and dead time veto. The data from scintillators, Cerenkov counters, silicon and MWPC go into event buffers.
- Buffers are read out during and after the spill and this data is accessible to experimenters. (Three bit event i.d. number is included in each event.)
- Experimenters can add their own trigger and deadtime signals.
- Rates on the order of 1 KHz have been achieved for the 4 second spill.

MTBF Detectors

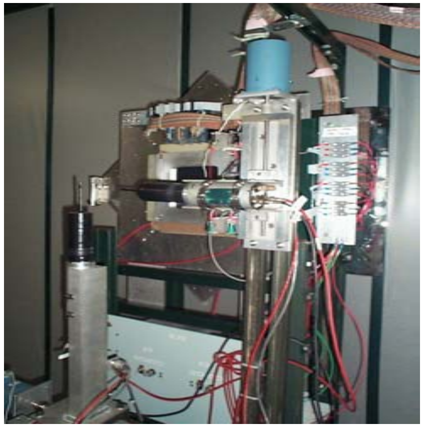


: Concrete
: Enclosed climate control areas
: Controlled access gate

Scint. PWC Finger counters Swic SSD

One of the two beamline Cerenkov counters

One of three MWPC stations



Remote controlled scintillator finger counters

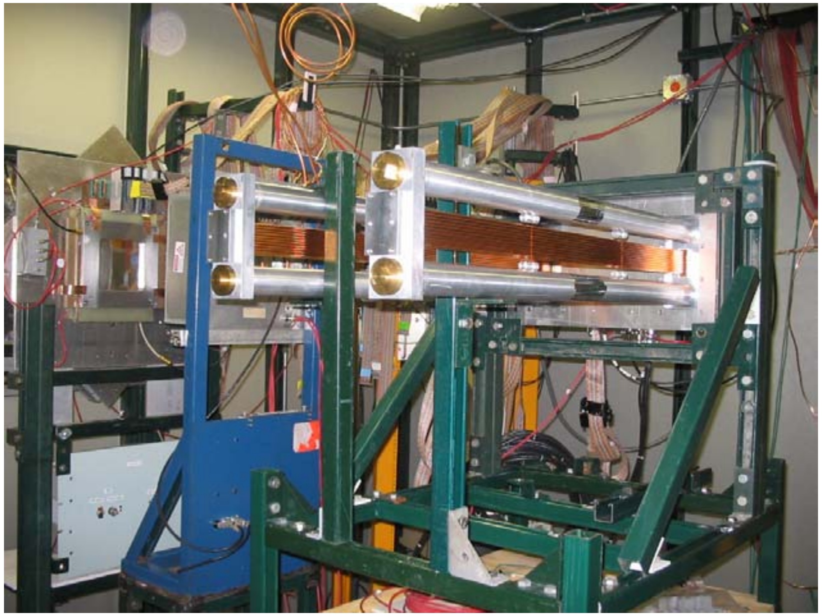
Silicon tracker

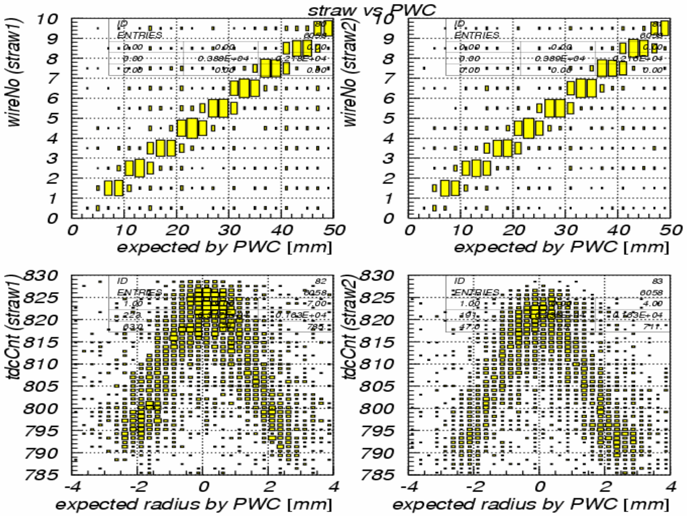
List of MTBF Memoranda of Understanding (MOU):

T926: RICE   **Experiment completed**
T927: BTeV Pixel   **Experiment completed**
T930: BTeV Straw   **Experiment completed**
T931: BTeV Muon   **Experiment completed**
T932: Diamond Detector   **Signed**
T933: BTeV ECAL   **Experiment completed**
T935: BTeV RICH   **Experiment completed**
T936: US/CMS Forward Pixel   **Taking data**
T941: UIowa PPAC Test   **Experiment completed**
T943: U. Hawaii Monolithic Active Pixel Detector   **Experiment completed**
T950: Vacuum Straw Tracker   **Taking data**
T951: ALICE EMCAL Prototype Test   **Taking data**
T953: U. Iowa Cerenkov Light Tests   **Signed**
T955: RPC Detector Tests   **In review**

T950 Straw Tracker Test

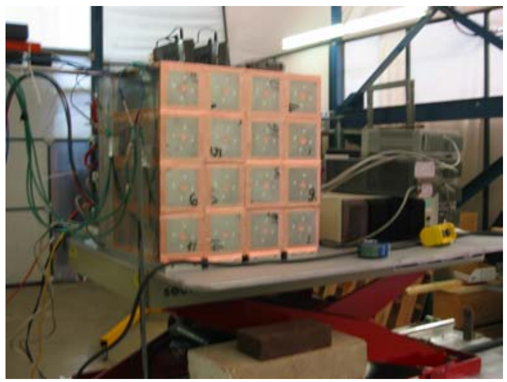
- Detector built at Fermilab for possible use at JPARC

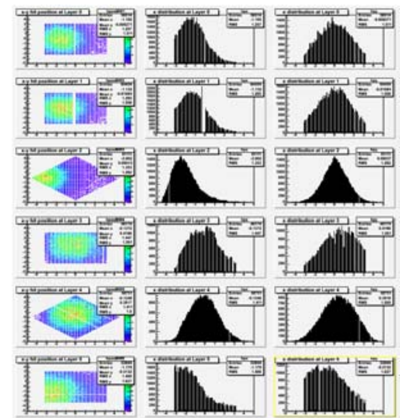




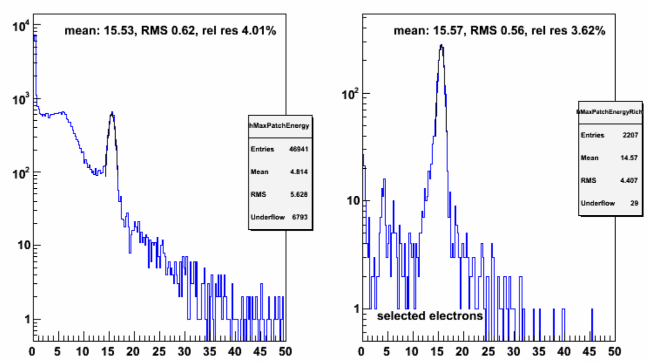
ALICE / PHENIX EMCal Test (T951)

Lead/scintillator calorimeter modules on facility's motion table.





Example of tracking output



Electron peak, without and with Cerenkov signal.

Possible future test beam initiatives

- Startup for T932 (diamond detector research), T953 (Cerenkov light tests) and T955 (RPC detector)
- Continuation of T936 (CMS pixel) and T950 (straw tracker)
- Jim Russ/CMU: silicon trackers for the LHC upgrade
- John Hauptman/Iowa State: dual readout calorimetry for the ILC
- Wojtek Dulinski/Strasbourg: irradiation tests for CMOS chip
- Victor Rykalin/NIU: extruded scintillator light yield
- Bob Abrams: ILC muon counters
- Mike Albrow: FP420 silicon tracking and timing counters
- Jae Yu/UTA: ILC calorimetry

An ILC test beam plan –
34 institutions, ~160 names

IV. Personnel and Institutions

The following Tables 2.a and 2.b list all participating institutions and the names of the physicists involved in the test beam program at Fermilab in this proposal. CALICE collaboration is by far the largest single-organization in this test beam program.

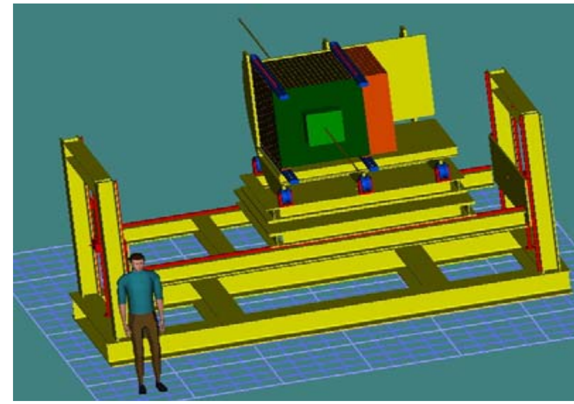
Table 2.a Part one of the list of institutions and personnel participating in ILC calorimeter program.

Institutions/Collaborations		Personnel Names
CALICE	Argonne National Laboratory	S.Chekanov, G.Drake, S.Kuhlmann, S.R.Magill, B.Musgrave, J.Repond, D. Underwood, B Wicklund, L Xia
	University of Texas at Arlington	A.Brandt, K.De, V.Kaushik, J.Li, M.Sosebee, A.White, J.Yu
	Nothern Illinois University/ NICADD	G. Blazey , D. Chakraborty, A. Dychkant, A. Maciel, M. Martin , R. McIntosh, V. Rykalin, V. Zutshi
	University of Birmingham, UK	C.M.Hawkes, S.J.Hillier, R.J.Staley, N.K.Watson
	Cavendish Laboratory Cambridge University, UK	C.G.Ainsley, G.Mavromanolakis , M.A.Thomson, D.R.Ward
	Laboratoire de Physique Corpusculaire – Clermont	F.Badaud, G.Bohner, F.Chandez, P.Gay, J. Lecoq, S.Manen, S.Monteil
	Joint Institute for Nuclear Research – Dubna, Russia	V.Astakhov, S.Golovatyuk, I.Golutvin, A.Malakhov, I.Tyapkin, Y.Zanevski, A.Zintchenko , S.Bazylev, N.Gorbunov, S.Slepnev
	DESY – Hamburg, Germany	G.Eigen, E.Garutti, V.Korbel, R.Poeschl, A.Raspereza, F.Sefkow
	Hamburg University, Germany	M.Groll, R.-D. Heuer, S.Reiche
	Kangnung National University – Kangnung, Korea	G.Kim, D-W. Kim, K.Lee, S.Lee
	Imperial College London, UK	D. Bowerman, B. Cameron, P. Dauncey, D.Price, O. Zorba
	University College London, UK	S. Bogeert, J.M.Butterworth, D.J.Miller, M.Postranecky ,M.Warren, M.Wing
	University of Manchester, UK	R.J.Barlow, I.P.Duerdoth, N.M.Malden ,D. Mercer, R.J.Thompson
	University of Minsk, Russia	N.Shumeiko, A.Litomin, P.Starovoitov, V.Rumiantsev, O.Dvornikov, V.Tchekhovsky, A.Solin, A.Tikhonov
	Institute of Theoretical and Experimental Physics – Moscow, Russia	M.Danilov, V.Kochetkov, I.Matchikhilian, V.Morgunov, S.Shuvalov
	Lebedev Physics Institute – Moscow, Russia	V. Andreev, E. Devitsin, V. Kozlov, P. Smirnov, Y. Soloviev, A. Terkulov
	Moscow Engineering and Physics Institute- Moscow, Russia	P.Buzhan, B.Dolgoshein, A.Ilyin, V.Kantserov, V.Kaplin, A.Karakash, E.Popova, S.Smirnov
	Moscow State University Moscow, Russia	P.Ermolov, D.Karmanov, M.Merkin, A.Savin, A.Voronin, V.Volkov

16

Table 2.b Part 2 of the list of the participating institutions and personnel in ILC test beam program.

Institutions/Collaborations		Personnel Names
CALICE	Laboratoire de l'Accélérateur Linéaire – Orsay, France	B.Bouquet, J.Fleury, G.Martin, F.Richard, Ch.de la Taille, Z.Zhang
	LPNHE - Université de Paris 6 et 7, France	A. Savoy-Navarro
	Charles University – Prague, Czech	S.Valkar, J.Zacek
	Institute of Physics, Academy of Sciences of the Czech Republic – Prague, Czech	J.Cvach, M.Janata, M.Lokajicek, S.Nemecek, I.Polak, J.Popule, M.Tomasek, P.Sicho, V.Vrba, J.Weichert
	Institute of High Energy Physics – Protvino, Russia	V. Ammosov, Yu.Arestov, B.Chuiko, V.Ermolaev,V.Gapienko, A.Gerasimov, Y.Gilitski,V.Koreshev, V.Lishin, V.Medvedev, A.Semak, V.Shelekhov, Yu.Sviridov, E.Usenko, V.Zaets, A.Zakharov
	School of Electric Engineering and Computing Science, Seoul National University	Ilgoo Kim, Taeyun Lee, Jaehong Park, Jinho Sung
University of Chicago		M. Oreglia
University of Oregon		R. Frey, D. Strom,
Stanford Linear Accelerator Laboratory		M Breidenbach
University of Kansas		G. Wilson, P. Baringer, A. Bean,
University of Colorado		U. Nauenberg
University of Iowa		Y. Onel
University of Washington		Tienchi
Fermilab		E. Ramberg, R. Yarema, H.E. Fisk,
University of Oklahoma		P. Skubic
Frascati, Italy		M. Piccolo, P. Checchia
Asian Collaborators should be in here!!		



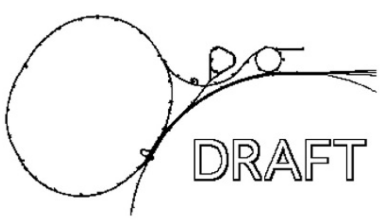
CALICE module test stand

- This proposal needed a long tem occupation (> 1 year) in MTBF.
- They need a broad range of particle types (e,π,μ,p)
- Requests for high energy electrons (>25 GeV) andlow energy pions (1 GeV) can't be met by current facility.
- Currently made plans to go to CERN SPS test beam for at least 2006.
- Possible move to FNAL, but poor duty cycle, lower beam energy and VISA issues make our facility less convenient.

Summary

- The Fermilab Meson Test Beam Facility is in full operation and supporting multiple users throughout the year.
- It can deliver approximately 100KHz of 120 GeV protons during the 4 second spill, which comes every 2 minutes.
- We can also tune between 4-66 GeV, with about 100 Hz of electrons between 4 and 16 GeV.
- A multiple station tracking system and DAQ has been developed and was used to good effect by several users.
- There are modest requests for the foreseeable future.
- Any long term installation of ILC calorimetry has been postponed at least until CERN test beam is completed at the end of 2006.

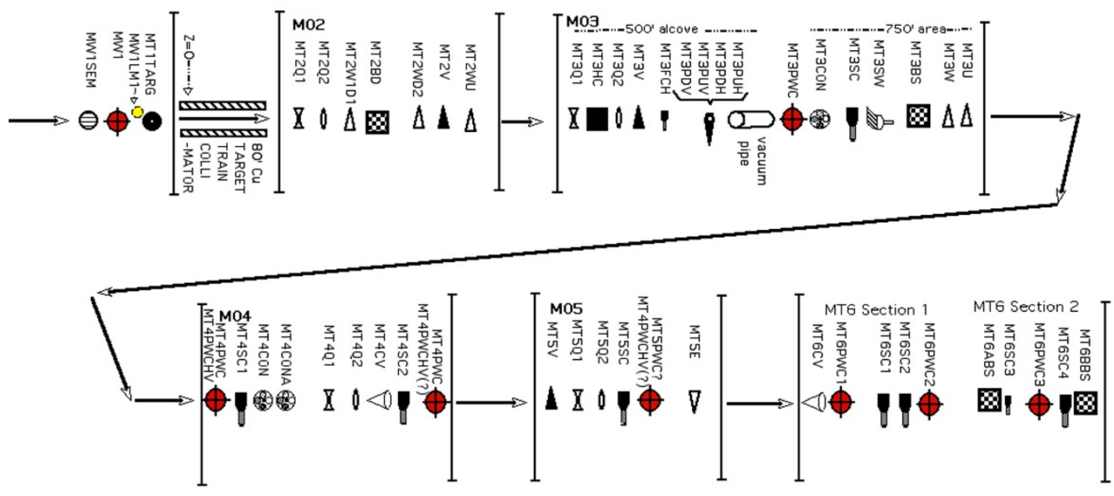
Spare slides



FNAL MT BEAM LINE

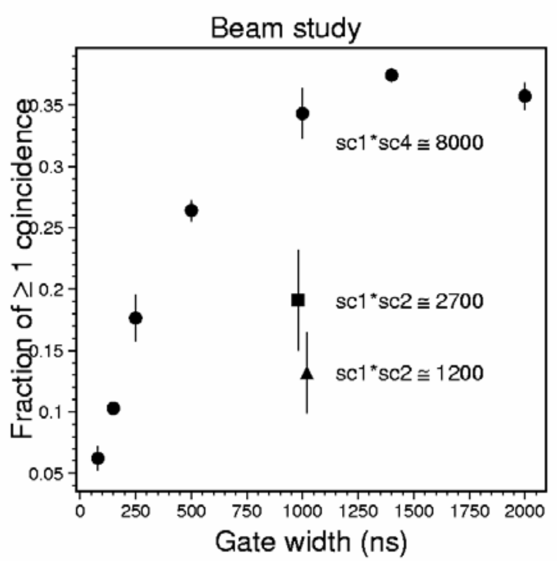
Please contact G. Koizumi for any corrections or changes.

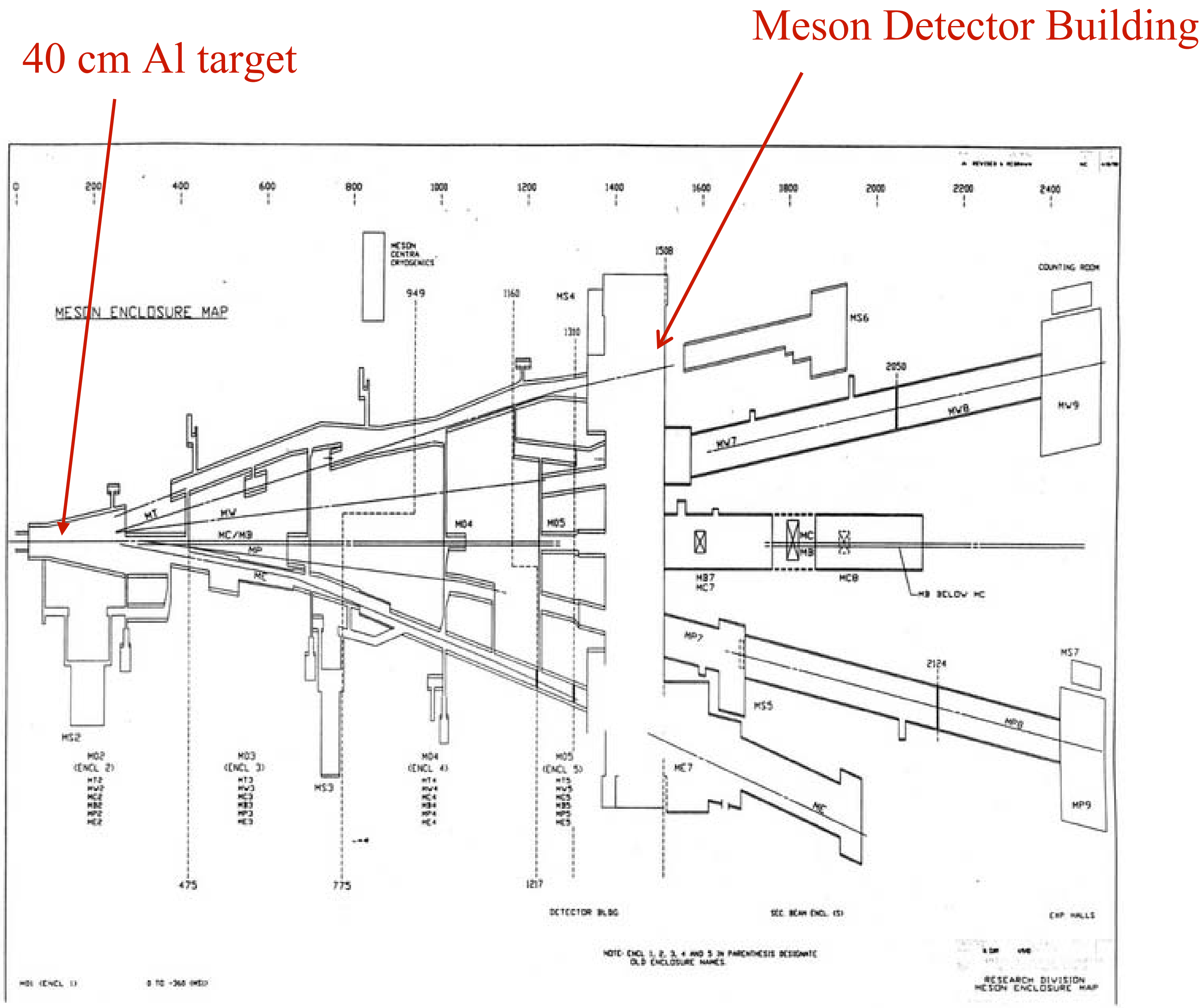
On file as: "MT Beam 12Apr04"
(on Zip disk: "Switchyard 120-3")



Multiple occupancy in test beam

- BTeV RICH test could identify multiple tracks in their detector as a function of gate width
- Multiples are on the order of 5% for 100 nsec gate width, rising up to about 35% for gate width of 1 μsec
- These results have probably gotten better in the last six months, but this has not been tested.

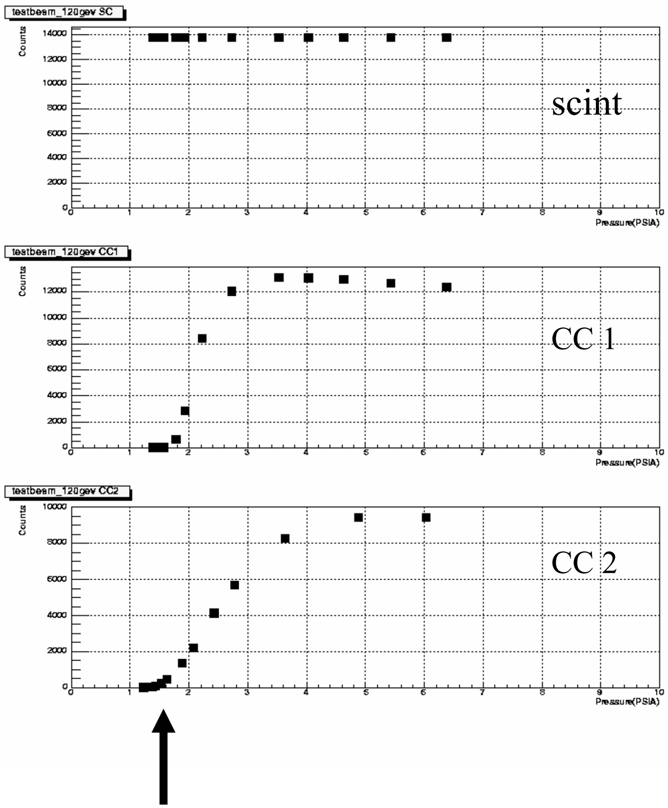




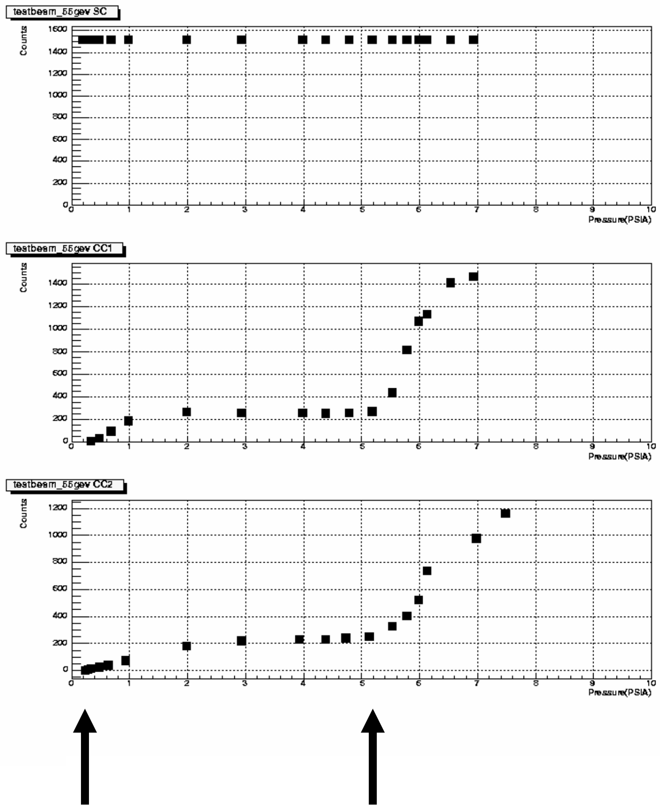
40 cm Al target
Meson Detector Building
MESON ENCLOSURE MAP
MESON CENTRAL CRYOGENICS
COUNTING ROOM
DETECTOR BLDG
MB BELOW MC
RESEARCH DIVISION
MESON ENCLOSURE MAP

Beamline Cerenkov results

120 GeV



66 GeV



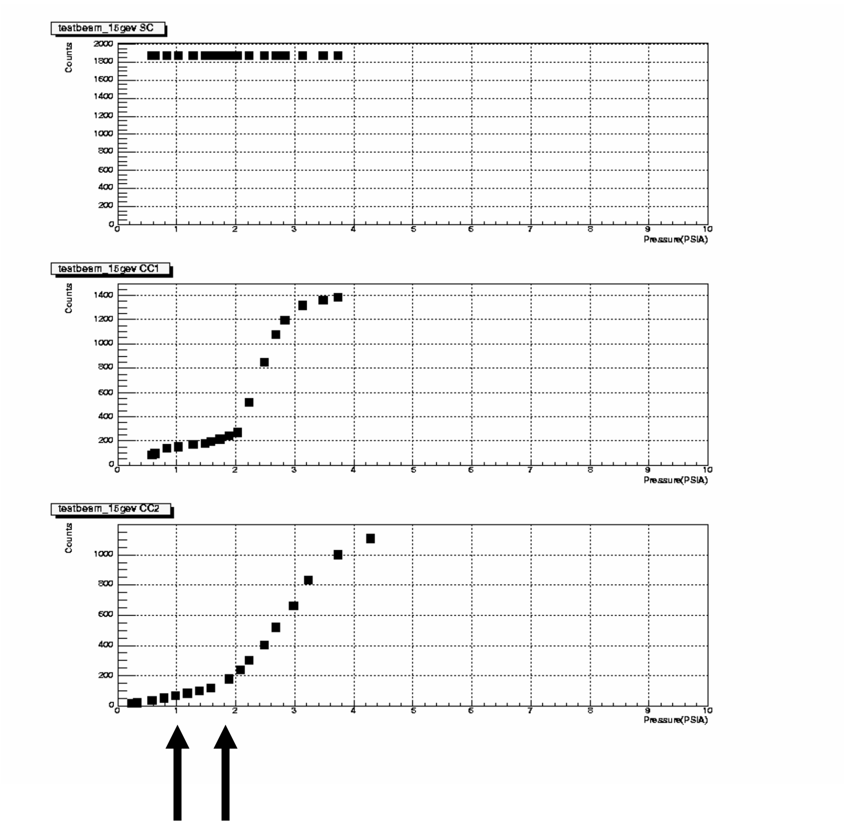
p threshold

π threshold

p threshold

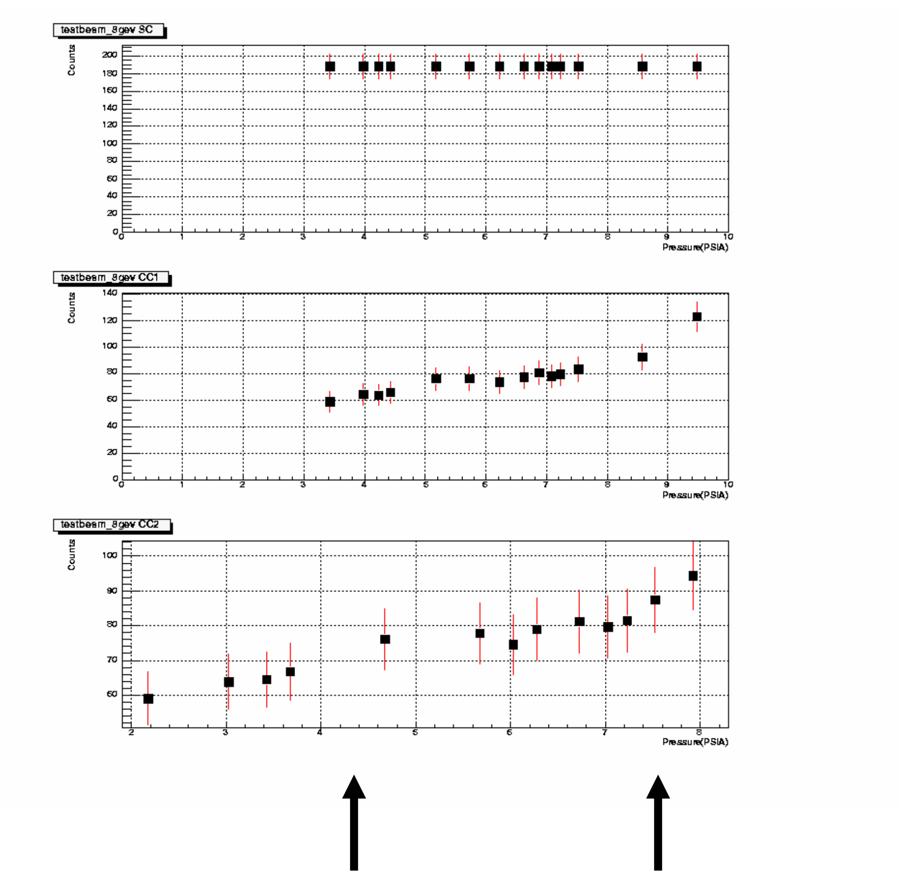
Cerenkov results (cont)

16 GeV



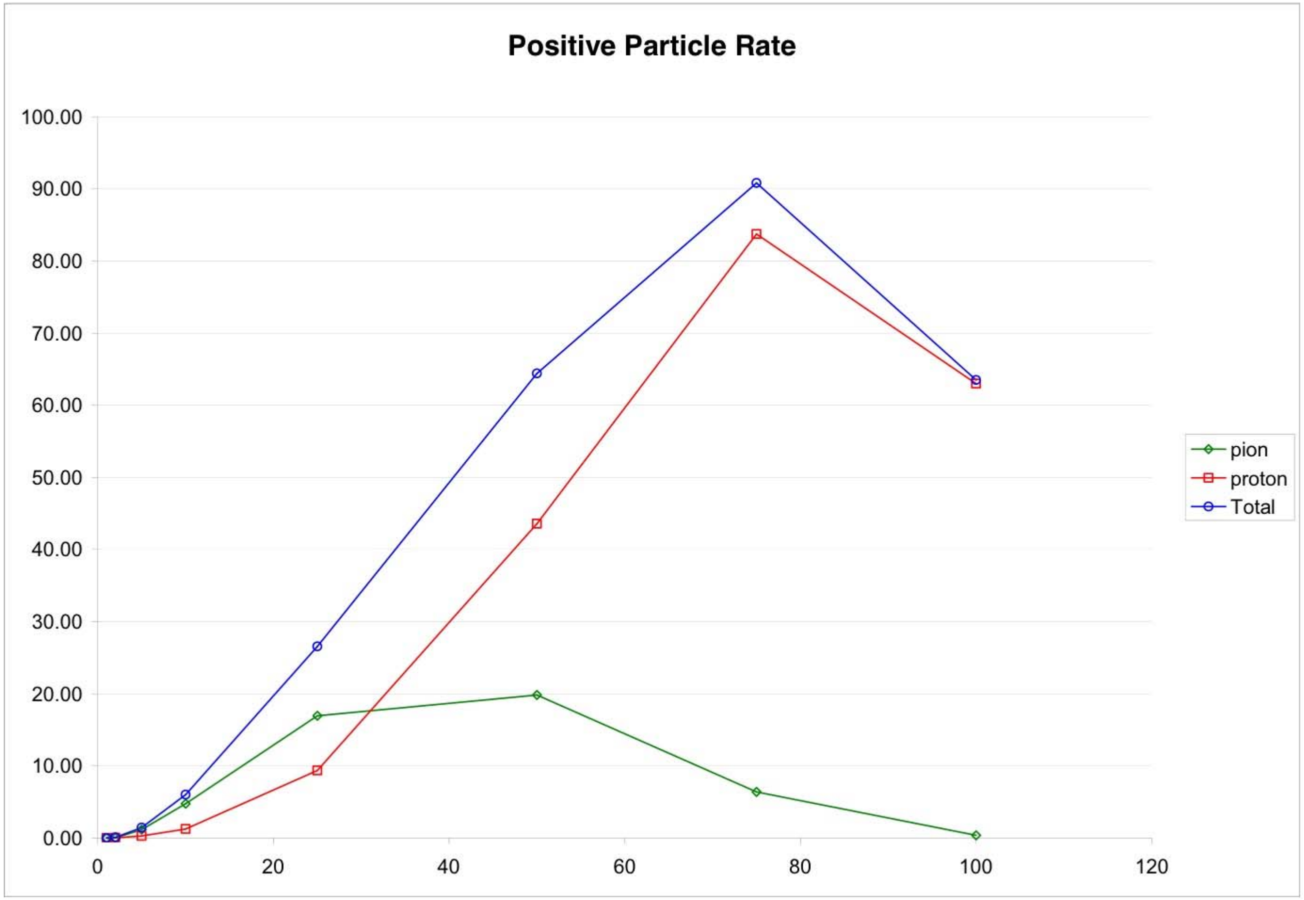
μ π threshold

8 GeV



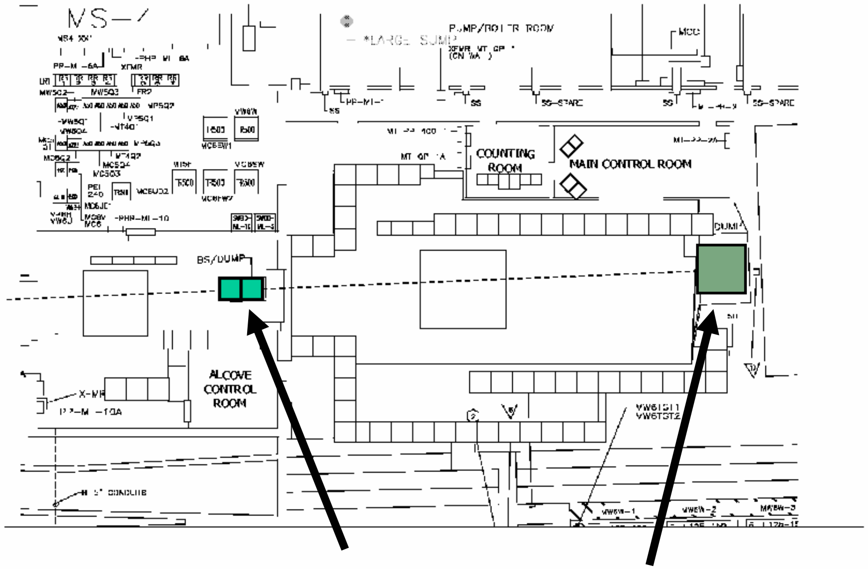
μ threshold π threshold

Simulation of test beam rates



Muons in MTBF

- Beam absorber between MT6A and MT6B is composed of two 4.5 ft sections of steel.
- With both sections in place, and 120 GeV beam incident, rate of muons at back of MT6B is ~10^{-6} μ/p/cm^2
- With only one section in place, and 120 GeV beam incident, rate of muons at back of MT6B is ~2 x 10^{-5} μ/p/cm^2
- Results above have been verified behind last absorber as well.



MT6A half absorber MT6B final absorber

Location of Meson Test Beam Facility DAQ devices